NOTES FROM PACIFIC COAST OBSERVATORIES.

IMPROVEMENTS IN THE CROSSLEY MOUNTING.

When the Crossley reflector was presented to the Lick Observatory in 1895 the mounting, which dated back to about the year 1880, was found to be lacking in the rigidity and steadiness necessary for successful photographic work. Many excellent photographs were secured with it in this form, but there were also many failures due primarily to the deficiencies of the mounting. It was accordingly remounted in 1905.[1] The change was a very complete one; to-day, absolutely all that remain of the original instrument and equipment as it came from England are the dome, the 36½-inch mirror, and the iron bucket which holds the lead clock weights.

The original mounting, as is well known, was of the fork form; for the new mounting Dr. PERRINE wisely chose the English equatorial form, with a long polar axis supported by a pier at each end. He was anxious to secure as long a driving arm as possible, to give great steadiness of movement, and so adopted the plan of driving by two sectors of 8-foot radius. The details of this double-sector drive were ingeniously worked out: there are two exactly similar sectors and driving worms; and while one sector is driving, the other is reversing at a slightly greater speed, so that the effect of a nearly continuous drive was secured. However, several minutes were lost each hour, as it was necessary for the observer to leave his guiding twice in this interval, once to stop the reversing sector at the end of its reverse, and once to change from one sector to the other. With sector A driving and sector B reversing, for instance, the cycle of operations was as follows:—

[1] *Lick Observatory Bulletin*, **3**, 124, 1905.

1. Stop motion of B at end of reverse.
   Interval of about fifteen minutes.
2. When A reached end of drive, cover plate, and move a shift lever, which caused both worms to drive.
3. Clamp in sector B.
4. Unclamp sector A.
5. Finish movement of shift lever; B now driving, A "dead."
6. Move another lever to cause A to reverse.

A movement of a lever in any way out of this specified order would stop the clock instantly, and this occasionally happened in the sleepy morning hours.

The change from a single central pier to the two piers of the new mounting necessitated the discarding of the rising platform of the original Crossley mounting, and in its place recourse was had to an upper floor with a large central opening. On this upper floor were two sliding sections, which could be moved out some distance over the central opening, and to reach the eye end in various positions of the telescope a six-foot and a nine-foot ladder were available. But in many positions of the telescope the use of this method entailed great strain and fatigue on the part of the observer; north of the zenith the only method available was a rather precarious plank scaffold stretched over the polar axis from one ladder to the other. The amount of labor involved in constant ascents and descents of these ladders when picking up faint objects, and in changing sectors and manipulating the dome, the sliding floor sections, and the ladders with changing hour angles, can be appreciated only by those who have worked with the instrument. It is only fair to Dr. PERRINE to state at this point that he always had in mind the installation of equipment to make the work of observing easier, but financial limitations at that time rendered necessary the adoption of less expensive expedients.

In February, 1910,[1] the instrument was dismounted and anti-friction roller-bearings were put in on both polar and declination axes, with other minor improvements. These changes added very greatly to the ease of motion of the telescope. Bearings of the same type had previously (1906) been

[1] *Publications A. S. P.*, **22**, 40, 1910.

put on the declination axis of the 37-inch Mills reflector at Santiago, but, so far as I know, this application to the Crossley was the first case in which such bearings were used thruout for a heavy instrument with the entire elimination of all friction wheels, counterpoises, and ordinary bearings. The old fear that such roller bearings would fail to give sufficiently steady motion or sufficient permanency of adjustment has been found to be entirely groundless, and the bearings of several large reflectors now being constructed will be of similar type.

With regard to the unique double-sector drive, were the instrument to be rebuilt, it is probable that a full worm wheel giving perfectly continuous drive would be used instead of the double-sector plan. Room for a wheel of sufficiently large radius would be secured by mounting it on a southern prolongation of the polar axis. This change in design would be made solely on the grounds of greater simplicity and to secure the advantages of a perfectly continuous drive, for the present sectors are equivalent to a driving wheel sixteen feet in diameter, and they drive beautifully.

When plans were made in May, 1913, to increase the efficiency of the Crossley accessory equipment, some thought was given to the project of discarding the present sectors and of mounting a full worm wheel inside the south bearing of the present polar axis. But the available bearing space for such a wheel is very small; the wheel would have had to be of a crowned or bell shape; the change would have made necessary a practically new clock; and the expense, particularly of the time necessary to grind up a new wheel which should drive as perfectly as the present sectors, seemed prohibitory. It was accordingly decided to keep to the present form of drive and to install an electrically-operated automatic sector-changer instead. At the same time designs were made and work was started on an adequate observing platform, an electric slow motion in right ascension, and electric clamps.

The general appearance of the changes made is shown in the accompanying photograph (see frontispiece). The observing platform is ten feet long by four and a half feet wide. It travels on wheels moving inside the flanges of two six-inch I-beams, which make an angle of 42° with the horizontal. The

distance of vertical travel of the platform is ten feet. The platform is raised and lowered by a one-half horse-power motor at the bottom of the frame, not visible in the picture. Long screws are used to raise and lower the platform, as this plan is self-locking, and no counter-weights are provided. The long screws have ball-thrust bearings at the upper ends, and are supported at the middle by bearings which automatically recede to allow the nuts fastened to the platform to pass by. Under the steps at the right are nine trolley wires, which carry the circuits from the platform to the dome and platform motors. Limit switches are provided to stop the platform automatically at its highest and lowest points. The controllers for moving the dome and the rising platform are located on the front of the small desk at the right end of the platform. The structural iron framework of the steps and platform support is rigidly attached to the dome and revolves with it. From the top of the steps a raised walk encloses the telescope on three sides. This is never used in ordinary observing, but is provided for emergencies in work at the zenith on special spectrographic or other problems which might necessitate unusual orientations of the movable end-section of the tube. A one-fourth horse-power motor has been installed to open and close the shutter. The endless cord for the slow motion in right ascension, which too often entangled itself on bolts or projections, has been supplanted by a small motor connected with the clock train by worm gearing.

The general scheme of the electric clamps can be clearly seen in the cut. Powerful solenoids, one for each sector, apply pressure to the clamp block through levers. Catches driven by springs and attached to the plungers of smaller unclamping solenoids are driven forward when the clamp lever reaches its highest point and hold it there. In unclamping, the smaller solenoid pulls back the catch and allows the clamping lever to fall.

The upper portion of the automatic sector-change mechanism may be seen through the small opening in the floor; this opening, as well as the worms, are kept covered during work. A full description of this mechanism could be given only with the aid of its working drawings. In brief, it consists of a strong shaft driven by worm and gearing from a small motor so as to

make one revolution in about twenty seconds. This shaft carries three cam wheels six inches in diameter; also a cylindrical commutator whose segments are properly shaped to give the necessary intermittent action in connection with contacts made by the sectors at each end of their travel. Twelve spring contacts bear on the commutator segments and provide for the automatic action of the cam shaft and shift gears, for the automatic clamping and unclamping when sectors are changing, and also provide selectively for the clamp switch at the eye end of the telescope, so that when one sector is driving only that sector may be clamped or unclamped by the observer. Roller-pins in the cam grooves give motion to the three rods which move the shift gears in the worm mechanism; the points of the shifting gears are chamfered as in automobiles, and in addition the rods are provided with spring joints, which give them one quarter of an inch play against strong springs. A full description of the intermittent action of the commutator and cams is unnecessary; it is sufficient to say that it goes through all the operations of the cycle in correct order, clamping and unclamping the proper sectors when the change is being made, is apparently infallible, and is entirely automatic, the observer giving no thought to the matter except to cover the plate with a light flap during the eight seconds needed for the change and until he again brings the guiding star up to the crosswire. During this change of sectors a red light goes on and a warning bell rings. It is possible to take up the unavoidable small "drift" of the guiding star with the electric slow motion and be guiding again 15 seconds after the warning bell starts to ring, which makes the drive practically continuous.

To avoid long cables in the electrical connections on the telescope tube the ten wires needed terminate in two sets of plugs at the upper end, one on each side of the tube, and are also carried to a similar bank of plugs at the lower end of the telescope. With the exception of the switch for manipulating the shutter, every operation is controlled either from the platform or from the eye end of the telescope, so that the observer need not leave the platform during a night's work. As direct photography with the instrument is carried on in entire darkness ruby lights are placed at the front corners of the

platform in parallel with the dome and platform controllers, so that the observer may be able to avoid striking the telescope when moving either the platform or the dome.

Among minor conveniences two may be mentioned which have been in use for several years: the right-angled finder (a disused comet seeker), and a counterbalanced mirror cover controlled by a cord over pulleys at the eye end so that the mirror may be quickly and easily covered when putting in or taking out a plate in positions near the zenith. The broken finder, in particular, has proved itself absolutely indispensable in actual work.

With the exception of the original mounting of the Crossley reflector, where the services of an assistant were necessary, all the Lick Observatory instruments have always been on the "one-man" plan, *i. e.* no assistant or helper is ever employed in the ordinary work of the 36-inch refractor or of the reflector, and experience has shown that the observer's personal convenience and freedom from fatigue, and the ability to cut down to a minimum the time and effort in starting work or changing from one object to another are factors fully as important as the possession of powerful equipment. In these respects the recently installed Crossley improvements have very greatly increased the efficiency of the instrument.

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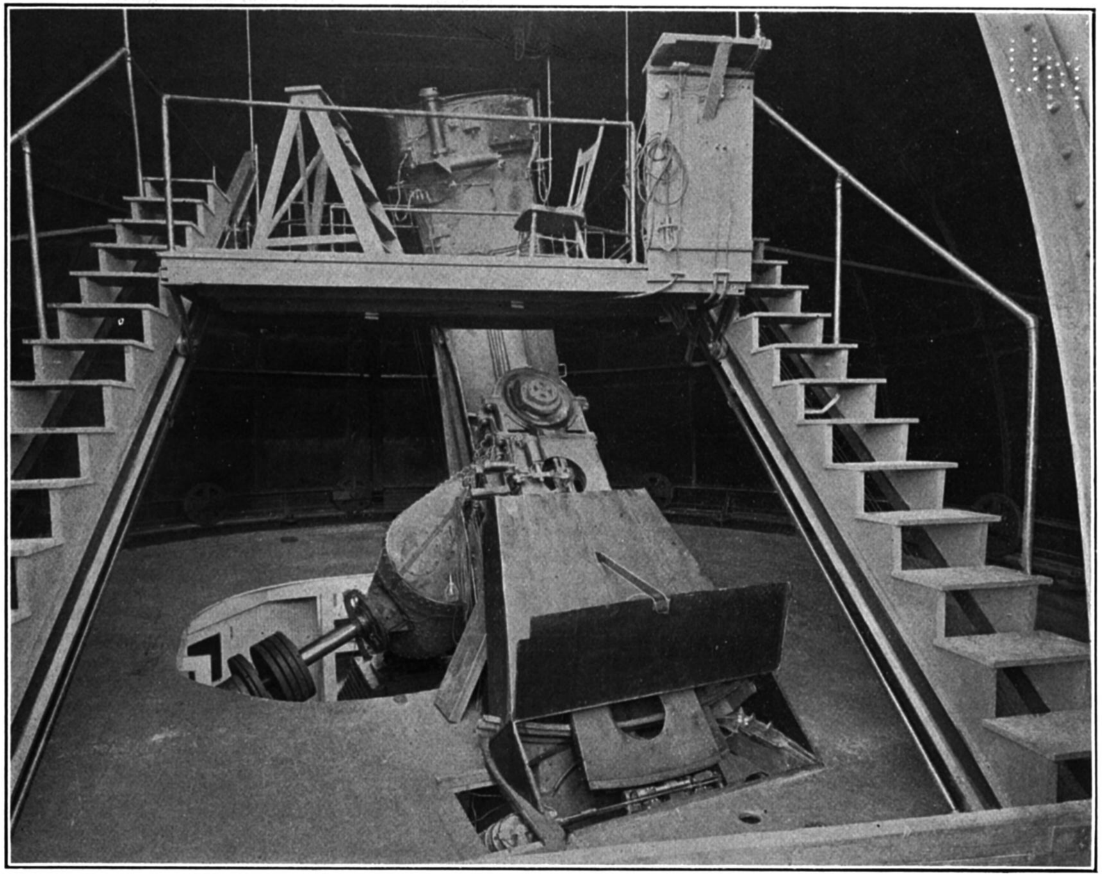
FAINT STANDARDS OF PHOTOGRAPHIC MAGNITUDE FOR THE SELECTED AREAS.

The purpose of this note is to describe briefly a program of photometric observations now in progress with the 60-inch reflector of the Mt. Wilson Solar Observatory. It involves the determination of the photographic magnitudes of the fainter stars immediately surrounding the central star of each of the 115 Selected Areas on and north of the celestial equator. The regions covered are 23′ in diameter, and it is proposed to determine upon an absolute scale the magnitudes of all the stars that may be registered with an exposure of 15 minutes. With satisfactory observing conditions, the limiting magnitude should be about 17.5 on the photographic scale. Altho the main interest of the investigation centers in the faint stars,



The Crossley Reflector, Showing Improvements.